BENHA VETERINARY MEDICAL JOURNAL, VOL. 35, NO. 1: 274-284, SEPT. 2018

Effect of Season on New Zealand White (NZW) Rabbits' Behavior and Reproductive and productive Performance

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A B S T R A C T

This work was carried out at the experimental animal center belonging to Faculty of Veterinary Medicine, Benha University through the period from July 2017 to the end of February 2018 to study the effect of season of year on behavior, reproductive and productive performance of breeding rabbits using 24 New Zealand White rabbits (18 females & 6 males) with age of 7 months. These animals were randomly assigned to two equal groups. One of these groups was reared during summer season under hot ambient temperature ranged from 28.7° C to 31.8° C and relative humidity ranged from 44.1 to 65.7 %, while the other group was reared during winter season under temperature ranged from 13° C to 20.4° C and relative humidity ranged from 51.55 to 63.3 %. All rabbits were reared under the same managerial conditions. Does were mated with mature bucks. Rabbits under heat stress during summer season showed low frequency of feeding, grooming and investigatory behaviors and low birth & weaning weight of kids. While there was no effect of the season on gestation length, litter size at birth ,conception rate, kindling rate or mortality rate. from this work, we can conclude that the behavior, reproductive and productive performance were negatively affected during summer season than during winter season.

Keywords:
Season, Rabbits, Behavior, Reproductive, productive performance.

(http://www.bvmj.bu.edu.eg) **(BVMJ-35(1): 274-284, 2018)**

1. INTRODUCTION

The breeding of rabbits is expanding; this is mainly attributable to the rabbit's high rate of reproduction, high genetic selection potential, rapid growth rate, early maturity, efficient feed utilization, high quality nutritious meat, and limited competition with humans for similar foods (Marai et al. 1999). Rabbits are hoped to play an important role in solving meat production deficiency particularly in the developing countries. These developing countries are mostly localized in tropical and subtropical regions so, rabbits are suffered from many problems related to hot climate particularly heat stress (Balabel, 2004). Seasonal changes in climate are associated with diverse changes in animals and plants (Eccles 2002). Summer and early autumn seasons are not within the thermo-neutral zone, suitable temperature for rabbits is around 18-20° C (Habeeb et al. 1998). Rabbits tend to have a constant internal body temperature (38.5-39.5° C) so, heat production must be coped the losses to maintain the body temperature constant and this can be achieved by modifying their ingestive behavior as the metabolic rate increased by about 20% in rabbits when exposed to high air temperature ranged from 30 to 35 °C (Rakes et al. 1988). Rabbits are homoeothermic animals as they can regulate the heat input and output of their bodies using physical, morphological, biochemical, and behavioral processes to maintain a constant body temperature (Marai et al. 1994). The high ambient temperatures are considered as one of the main constrictions of animal reproduction as they adversely affect the reproductive performance of rabbit and limit their breeding season to the period between September and May (Ain-baziz et al. 2012). Rabbit does are very sensitive to heat stress which is considered as an important factor influencing their fertility and also has bad effects on most of their reproductive and physiological traits (Askar and Ismail 2012). The object of this experiment was studying the effect of season of year on the breeding rabbit behavior and reproductive performance.

2-Materials & Methods:

The present study was carried out at the experimental animals' center belonging to Faculty of Veterinary Medicine, Benha University.

Animal housing:

The laboratory animals house included two rooms, each of them was 3.80 x 2.75 m floor and 2.85 m height. Rabbits were housed individually in galvanized wire cages (pyramidal batteries) 50 x 40 x 30 cm. The lighting schedule was 14 lighting hours (Artificial lighting) and 10 hours dark according to Sandford (1996). Inside the laboratory animal rooms, indoor ambient temperature (° C) and relative humidity (RH %) were daily recorded using digital thermo-hygrometer.

Feed (Rabbit Pellets) and water were always available. All rabbits were fed standard nutritionally complete rabbit pelleted diet that was produced by private company. The ration contained the following ingredients.

Table (1)

Crude protein	18 %
Crude fat	3 - 4 %
Metabolized energy	2520 kcal/Kg
Crude fibers	13 - 15 %

Breeding:

Does were inspected daily for the signs of receptivity. Receptive doe was taken to the buck cage then returned back to their cages after being bred. Pregnancy was diagnosed through abdominal palpation at 10^{th} – 14^{th} days post mating. On 27^{th} day of pregnancy, the nest box of doe cage was supplied by rice straw litter to provide a comfortable and warm place for kindling and rearing of the bunnies. Weaning of the kids was achieved at one month.

Vaccination and Medication:

Inactivated rabbit hemorrhagic disease virus vaccine was injected subcutaneously as a prophylactic measure at a dose rate of (0.5 ml /
Rabbit, *Veterinary Search and Vaccination Research Institute, Cairo, Egypt*). Oil adjuvant poly valent rabbit Pasteurellosis vaccine was injected subcutaneously at a dose rate of (1 ml / rabbit) at 2 months of age and (2 ml / rabbit) at 4 months of age (*Veterinary Search and Vaccination Research Institute, Cairo, Egypt).* Ivermectin was injected subcutaneously as prophylactic to control the internal and external parasites. E – Selenium and AD_3E vitamins and mineral mixture were added to

the drinking water three times per week at a dose rate of (1 ml/liter) to raise the rabbits' vitality throughout the experimental period.

Experimental Design:

The present work was carried out for 10 weeks through the period from 15th July to the end of September 2017 during summer season and10 weeks through the period from15th December 2017 to the end of February 2018 during the winter season using 24 NZW rabbits (18 females + 6 males) with age of 7 months. These animals were divided into two groups:

Group I: was reared during summer season

Group II: was reared during winter season

Summer group was subjected to temperatures fluctuated between 28.7° C and 31.8° C with relative humidity held between 44.1 – 65.7 % during the days of examination. Winter group was subjected to temperatures fluctuated between 13 °C and 20.4° C with relative humidity held between 51.5 – 63.3 %.

Data Collection and Recording:

1- Behavioral observation and data collection:

. The behavioral observation was performed using focal sample technique according to the recommendation of paul and patric (2007).

Rabbits were observed three times on each day of observation: at early morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.). The behavior of each rabbit was observed for 3 days per week of the experimental period; 3 different time periods per day of examination (10 minutes for each period).

The frequency of each behavior was calculated as the total number of its occurance per 10 minutes for each rabbit through the experimental period.

Behavioral patterns:

The observed behavioral patterns were recorded according to Jordan et al. (2011) as the following:

1- Feeding behavior: rabbits were standing next to the feeder, taking out pellets and chewing them.

2- Drinking behavior: consumption of water from the nipple drinker.

3- Body care: where the following behavioral patterns were separately recorded.

a- Grooming: licking and nippling the fur, washing faces with fore limbs, licking ears held in front of the snout with fore limbs

b- Scratching: the hind feet were used to scratch the body, neck, face and ears. Scratching was usually followed by licking the end of the foot used for scratching lasting few moments

4- Resting: according to the body posture rabbits adopt three postures:

a- Resting-Abdominal posture: resting with the belly on the ground, the hind limbs tucked under the body and fore limbs either tucked beneath the body or stretched forward. The head was in upward position.

b- Resting-Abdominal lateral Posture: resting with the body trunk on the ground, fore limbs either tucked beneath the body or stretched forward and hind limbs more or less stretched away from the body. The head was usually in upward position.

c- Resting-Lateral Posture: resting on the side with all fore legs stretched away from the body and the head was in lying.

5- Investigatory: behavior forms connected to the cage or its equipment (rubbing, licking, gnawing, smelling and marking with the chin).

6- Behavioral Disorders: biting the wire and cage equipment fur chewing and cannibalism.

2- Reproductive & productive Performance:

a. Gestation Period was counting the days elapsed from time of mating till kindling.

b. Litter Size (Number of kids (still birth , live kids) given by each doe).

c. Kids weight at birth and weaning.

d. Conception rate % (CR) was calculated according to Oguike and Okocha (2008)

CR =number of does that pregnant/ total number of doe mated.

e. Kindling Rate = Number of does that kindled / Number of does in each experimental group.

f. Mortality rate for kids from birth till weaning.

g. Mortality %: Mortality cases were recorded daily and the percentage was recorded for each group at the end of the experiment.

Weaning was done at 4 weeks from birth in all groups.

3-Results:

Table (2): Effect of season on frequency of some behaviors in breeding rabbits.

Behavioral Parameters			Feeding	Drinking	Resting	Body Care	Investigatory Behavior	Abnormal Behavior
Season	Winter		0.89 ± 0.10 ^{a}	0.28 ± 0.07^{a}	1.08 ± 0.04^{a}	0.58 ± 0.09^{a}	0.42 ± 0.06^{a}	0.00 ± 0.00 ^{a}
	Summer		0.25 ± 0.10 ^{b}	0.33 ± 0.07^{a}	1.00 ± 0.04^{a}	0.25 ± 0.09^{b}	0.08 ± 0.06^{b}	0.08 ± 0.03 ^{a}
Periods	At morning (8-9 a.m.)		0.63 ± 0.12 ^{a}	0.25 ± 0.09^{a}	0.96 ± 0.05^{a}	0.38 ± 0.11^{a}	0.45 ± 0.08^{a}	0.04 ± 0.04 ^{a}
	At early Afternoon (12-1 p.m.)		0.42 ± 0.12 ^{a}	0.50 ± 0.09^{a}	1.08 ± 0.05^{a}	0.50 ± 0.11^{a}	0.17 ± 0.08^{a}	0.08 ± 0.04 ^{a}
	At late Afternoon (4-5 p.m.)		0.67 ± 0.12 ^{a}	0.13 ± 0.09^{a}	1.08 ± 0.05^{a}	0.38 ± 0.11^{a}	0.13 ± 0.08^{a}	0.00 ± 0.00 ^{a}
Season-Periods Interaction	Winter	At Morning (8-9 a.m.)	0.92 ± 0.18 ^{a}	0.25 ± 0.12^{b}	0.92 ± 0.07^{b}	0.67 ± 0.16^{a}	0.83 ± 0.11^{a}	0.00 ± ^{a} 0.00
		At early Afternoon (12-1 p.m.)	0.67 ± 0.18 $^{a b}$	0.33 ± 0 .12^{b}	1.17 ± 0.07^{a}	0.58 ± 0.16$^{a b}$	0.17 ± 0.11^{b}	0.00 ± 0.00 ^{a}
		At late Afternoon (4-5 p.m.)	1.08 ± 0.18 ^{a}	0.25 ± 0 .12^{b}	1.17 ± 0.07^{a}	0.50 ± 0.16$^{a b}$	0.25 ± 0.11^{b}	0.00 ± 0.00 ^{a}
	Summer	At morning (8-9 a.m.)	0.33 ± 0.18 ^{b}	0.25 ± 0.00^{b}	1.00 ± 0.07$^{a b}$	0.08 ±^{b} 0.16	0.08 ± 0.11^{b}	0.08 ± 0.06 ^{a}
		At early Afternoon (12-1 p.m.)	0.17 ± 0.18 ^{b}	0.67 ± 0 .12^{a}	1.00 ± 0.17^{a}	0.42 ±^{a} 0.16	0.17 ± 0.11^{b}	0.17 ± 0.06 ^{a}
		At late Afternoon (4-5 p.m.)	0.25 ± 0.18 ^{b}	0.00 ± 0 .00^{b}	1.00 ± 0.07$^{a b}$	0.25 ±^{b} 0.16	0.00 ± 0.00^{b}	0.00 ± 0.00 ^{a}

Data was presented as Mean ± Standard Error (SE). Values with different superscript letters within the same column were significantly different at $p < 0.05$.

Data in Table, 2 revealed that the frequency of feeding behavior was significantly ($P < 0.05$) higher in winter than in summer season.

Our study cleared that the frequency of body care and investigatory behaviors was significantly ($P < 0.05$) higher in winter season than that in summer season.

Table (3): Effect of season on some reproductive & productive parameters in breeding rabbits.

Groups / Reproductive Parameters	Winter Group	Summer Group
Gestation Length (days)	31.22 ± 0.28 [a]	31.71± 0.28 [a]
Litter Size at Birth (kids)	4.67 ± 0.67 [a]	4.56 ± 0.67 [a]
Weight of Kid at Birth (gm)	53.38 ± 4.05 [a]	37.56 ± 4.05 [b]
Weight of Kid at Weaning (gm)	374.44 ± 30.86 [a]	304.78 ± 30.86 [b]
Conception Rate (%)	100 ± 0.00 [a]	100 ± 0.00 [a]
Kindling Rate (%)	100 ± 0.00 [a]	100 ± 0.00 [a]
Preweaning mortality (30days) (%)	26.82 ± 0.58 [a]	26.19 ± 0.58 [a]
Mortality rate of breeding rabbits (%)	0 ± 0.00 [a]	0 ± 0.00 [a]

Data was presented as Mean ± Standard Error (SE). Values with different superscript letters within the same raw were significantly different at $p< 0.05$.

Data in table, 3 showed that the mean weight of kid at birth and at weaning was significantly ($P < 0.05$) higher in winter season than that in summer season.

4-Discussion:

Data presented in Table, 2 showed that the effect of season on frequency of some behaviors in breeding rabbits. The frequency of feeding behavior was 0.89 ± 0.10 and 0.25 ± 0.10 for winter and summer seasons, respectively.

From the obtained results, it was observed that the frequency of feeding behavior was higher in winter than in summer season and there was a significant difference ($P < 0.05$) in the frequency of feeding due to the season. These findings were in agreement with Rakes et al. (1988); Marai et al. (1994); Balabel (2004) and Okab et al. (2008) who explained that the exposure of rabbits to high air temperature resulted in inhibition of hypothalamic appetite center in the brain, so reducing feed intake.

Regarding the effect of the period on the feeding, the average feeding frequency was 0.63 ± 0.12, 0.42 ± 0.12 and 0.67 ± 0.12 at morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.), respectively. From the obtained data, it was observed that the average of feeding frequency was the highest at the late afternoon followed by the morning and the early afternoon, respectively, but without a significant difference ($P < 0.05$) in the frequency of feeding between the different periods of the season.

Regarding season-period interaction, the average feeding frequency was 0.92 ± 0.18, 0.67 ± 0.18 and 1.08 ± 0.18 at morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.) periods in winter season, respectively and 0.33 ± 0.18, 0.17 ± 0.18, and 0.25 ± 0.18 at morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.) periods in summer season, respectively.

From the obtained data, it was observed that the average feeding frequency was higher in all periods of the winter season than those in the summer season and there was a significant difference ($P < 0.05$) in the frequency of feeding at the early morning and late afternoon in the winter season.

These findings may be attributed to the higher temperatures during the different periods during summer season than those during winter season. These findings coincide with Rakes et al. (1988) and Habeeb et al. (1993) who mentioned that rabbits tend to have a constant internal body temperature so, heat production must be coped the losses to maintain the body temperature constant and this can be achieved by modifying their ingestive behavior as the metabolic rate increased by about 20% in rabbits when exposed to high air temperature ranged from 30 to 35 °C.

Data presented in Table, 2 showed that the effect of season on frequency of drinking behavior in breeding rabbits. The frequency of drinking was 0.28 ± 0.07 and 0.33 ± 0.07 for winter and summer seasons, respectively.

From the obtained results, it was observed that the frequency of drinking behavior was higher in summer than in winter season, but there was no significant difference ($P < 0.05$) in the frequency of drinking due to the season.

Regarding the effect of the period on the drinking, the average drinking frequency was 0.25 ± 0.09, 0.50 ± 0.09 and 0.13 ± 0.09 at morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.), respectively. From the obtained data, it was observed that the average drinking frequency was the highest at the early afternoon followed by the morning and the late afternoon, respectively, but there was no significant difference in the frequency of drinking between the different periods of the season.

Regarding season-period interaction, the average drinking frequency was 0.25 ± 0.12, 0.33 ± 0.12 and 0.25 ± 0.12 at morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.) periods in winter season, respectively and 0.25 ± 0.12, 0.67 ± 0.12, and 0.00 ± 0.00 at morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.) periods in summer season, respectively. From the obtained data, it was observed that the average of drinking frequency was the highest at early afternoon in the summer season and there was a significant difference ($P < 0.05$) in the frequency of drinking at the early afternoon of summer season. This may be attributed to high temperature during this period so high water consumption during heat stress helps the animals to increase the heat loss through vaporization of water during respiration and this coincide with Chiericato et al. (1992) and Balabel (2004).

Data presented in Table, 2 showed that the effect of season on frequency of resting behavior in breeding rabbits. The frequency of resting was 1.08 ± 0.04 and 1.00 ± 0.04 for winter and summer seasons, respectively.

From the obtained results, it was observed that the frequency of resting behavior was higher in winter than in summer season, but there was no significant difference in the frequency of resting due to the season.

Regarding season-period interaction, the average resting frequency was 0.92 ± 0.07, 1.17 ± 0.07 and 1.17 ± 0.07 at morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.) periods in winter season, respectively and 1.00 ± 0.07, 1.00 ± 0.07, and 1.00 ± 0.07 at morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.) periods in summer season, respectively.

From the obtained data, it was observed that the average of resting frequency was higher at the early and late afternoon periods in the winter season than the other periods and there was a significant difference ($P < 0.05$) in the frequency of resting at the early and late afternoon periods in the winter season.

Data presented in Table,2 showed that the effect of season on frequency of resting behavior in breeding rabbits. The frequency of resting was 1.08 ± 0.04 and 1.00 ± 0.04 for winter and summer seasons, respectively.

From the obtained results, it was observed that the frequency of resting behavior was higher in winter than in summer season, but there was no significant difference in the frequency of resting due to the season.

Regarding the effect of the period on the resting, the average resting frequency was 0.96 ± 0.05, 1.08 ± 0.05 and 1.08 ± 0.05 at morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.), respectively. From the obtained data, it was observed that the average of resting frequency was higher at the early and late afternoon than at the morning, but there was no significant difference in the frequency of resting between the different periods of the season.

Regarding season-period interaction, the average resting frequency was 0.92 ± 0.07, 1.17 ± 0.07 and 1.17 ± 0.07 at morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.) periods in winter season, respectively and 1.00 ± 0.07, 1.17 ± 0.07, and 1.00 ± 0.07 at morning (8-9 a.m.), early afternoon (12-1 p.m.) and late afternoon (4-5 p.m.) periods in summer season, respectively. From the obtained data, it was observed that the average of resting frequency was higher at the early late afternoon periods in the winter season and early afternoon of summer season than the other periods and there was a significant difference ($P < 0.05$) in the frequency of resting at the early and late afternoon periods in the winter season.

Regarding to body care and investigatory behaviors, the frequency of body care behavior was 0.58 ± 0.09 and 0.25 ± 0.09 for winter and summer season, respectively, while the frequency of investigatory behavior was 0.42 ± 0.06 and 0.08 ± 0.06 for winter and summer season, respectively.

Our study cleared that the frequency of body care and investigatory behaviors was significantly increased in winter season than that in summer season. These results agreed with Finzi et al. (1992) who found that active behaviors of rabbits (grooming and investigatory) decreased significantly during summer season. This may be attributed to that high temperature during summer season decreases feed intake and so decreases the activity of rabbits Marai and Rashwan (2004). Heat stress decreases thyroid hormones that are needed for metabolism to produce activities and metabolic heat production (Habeeb et al. 1993 and Marai et al. 1994).

Regarding season–period interaction for body care and investigatory behaviors, the frequency of body care and investigatory behaviors increase significantly during early morning of winter season than the other periods.

Regarding the behavioral disorders, the season had non-significant effect on the frequency of the behavioral disorders.

Data presented in Table, 3 showed the effect of season on some rabbits reproductive and productive performance in breeding rabbit. The gestation lengths were (31.22 ± 0.28, 31.71 ± 0.28) for winter and summer seasons respectively. From the obtained results it was clear that gestation length was longer in summer season than that in winter season , but the difference was not statistically significant. These findings disagreed with Balabel (2004) who found that gestation period decreased significantly in rabbits exposed to high ambient temperatures.

Regarding the litter size at birth. The litter size at birth was 4.67 ± 0.67 and 4.56 ± 0.67 for winter and summer seasons respectively. From the obtained results, it was observed that the litter size at birth was higher in winter season than in summer season, but the difference was not statistically significant. These results were in agreement with Balabel (2004) and Mahmoud (2013) who found that, litter size at birth was lower in summer season than winter season and they attributed these findings to seasonal variation in ambient temperature and relative humidity and availability of green fodders during winter season which supply fresh source of vitamins and minerals to the reproductive animals so increase fertility during winter season.

Regarding the weight of kid at birth and at weaning. the weight of kid at birth was 53.38 ± 4.05 & 37.56 ± 4.05 gm for winter and summer seasons., respectively. The mean weight of kid at weaning was 374.44 ± 30.86 & 304.78 ± 30.86 gm for winter and summer seasons., respectively. From the obtained results it was clear that the mean weight of kid at birth and at weaning was heavier in winter season than that in summer season, but with a significant difference ($P < 0.05$).These findings were in agreement with Abd-Elmonem (2009) and Mahmoud (2013) who found that weight of kid at birth was higher in kids born during mild periods than those born during hot periods and attributed this to feed intake of dams which increased significantly during winter season than summer season and availability of green fodders during winter season that lead to increasing of birth weight and milk production of does during winter season. These findings were not in agreement with Awojobi et al. (2011) who reported that litter weight at birth was higher in dry season than rainy one.

Regarding the Conception rate, the kindling rate and the mortality rate of breeding rabbits seemed to be not affected by season. These results disagreed with Tharwat et al. (2004) who reported that the conception rate during autumn and spring was higher than that recorded during summer season. These findings may be attributed to low sperm cell concentration per ejaculate and high percentage of dead sperms obtained during summer season.

Regarding the Pre-weaning mortality, It was 26.82 ± 0.58% & 26.19 ± 0.58%., for winter and summer season, respectively). Our results showed that the Pre-weaning mortality in winter season was higher in winter season than that in summer season. but there was no significant differences between them (26.82 ± 0.58% & 26.19 ± 0.58%., respectively). Our results agreed with Ayaat and Marai (1997) who found non-significant increase of pre-weaning mortality rate in summer and winter seasons, but These findings disagreed with Habeeb et al. (1999) and Marai et al. (2001) who found that pre-weaning mortality increased during summer season.

5-Conclusion:

From the obtained results we can conclude that elevated ambient temperature and relative humidity (Heat stress) during summer season had significant adverse effects on behavior, reproductive and productive performance of breeding NZW rabbits than those reared during winter season, so it is advisable for rabbit breeders to avoid breeding of rabbits during summer season unless good managerial procedures such as usingof air conditioned farms, providing the rabbits with vitamin C in the drinking water, shearing the fur are applied for decreasing the harmful effects of summer season on the breeding rabbits.

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